

TECHNICAL MANUAL

Model: tech-50^{TM*}
Portable Survey Meter

Manual Part No. 1017902

<u>Issue</u>	<u>Date</u>
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BICRON

ELECTRONIC PRODUCTS STANDARD WARRANTY

Bicron Electronic Products Instruments and options are warranted against defects in materials and workmanship for a period of one year from the date of shipment, unless otherwise agreed upon by Bicron and the customer.

Bicron's obligation with regard to such products shall be limited to repair or replacement, FOB Bicron factory or authorized repair station, at Bicron's option.

The calibration (when applicable) for each instrument is warranted to be within its specified accuracy at the time of shipment. If this initial calibration is determined to be in error, the instrument will be recalibrated at no charge, provided it is returned as described above.

EXCLUSION OF WARRANTY

The aforesaid warranty does not cover life-end failure of components and will be voided if repair has been attempted by other than Bicron's authorized personnel. In no event shall Bicron be liable for consequential or special damages.

transportation, installation, adjustment, work done by customer or other expenses which may arise in connection with such defective product or parts.

There are no warranties, express or implied, including without limitation any implied warranty of merchantability or fitness, which extend beyond the description of the face hereof. This express warranty excludes coverage of and does not provide relief for incidental or consequential damages of any kind or nature, including, but not limited to loss of use, loss of sales or inconvenience. The exclusive remedy of the purchaser is limited to repair, recalibration, or replacement of the instrument at Bicron's option.

This warranty specifically excludes the following items which are covered by their original manufacturers' warranties: photomultiplier tubes, GM and proportional tubes, crystal and other solid-state detectors, and batteries.

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BICRON CORPORATION
ELECTRONIC PRODUCTS

PROCEDURES and CAUTIONS

The equipment herein described is designed and manufactured in compliance with all applicable safety standards. Nevertheless, certain hazards are inherent in the use of electronic and radiometric equipment.

Adequate warnings are included in the manual and on the product itself to cover hazards that may be encountered in normal use and servicing of this equipment. No other procedures are warranted by Bicron.

It shall be the owner's or user's responsibility to see to it that the procedures herein are meticulously followed, and especially that the warning and cautionary notes are heeded.

Failure on the part of the user in any way to follow the prescribed procedures shall absolve Bicron and its agents from any resulting liability.

This instrument is intended solely for the detection and measurement of ionizing radiation. It should be used only by persons who have been trained in the proper interpretation of its readings and the appropriate safety procedures to be followed in the presence of radiation.

All instructions and warnings contained in this manual or on the instrument must be read before use and must be strictly followed. Failure to follow these instructions and warnings may result in inaccurate readings and/or user hazard.

Indicated battery and other operational tests must be performed prior to each use to assure that the instrument is functioning properly.

*****CAUTION*****

FAILURE TO CONDUCT PERIODIC PERFORMANCE TESTS IN ACCORDANCE WITH ANSI N323-1978, PARAGRAPHS 4.6 and 5.4, AND TO KEEP RECORDS THEREOF IN ACCORDANCE WITH PARAGRAPH 4.5 OF THE SAME STANDARD, COULD RESULT IN ERRONEOUS READING OF POTENTIAL DANGER. ANSI N323-1978 BECOMES, BY THIS REFERENCE, A PART OF THIS OPERATING PROCEDURE.

INSPECTION

Instruments should be examined and tested as soon as received. Claims for transportation damages, if any, should be filed at once with the delivery carrier.

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1.0 GENERAL DESCRIPTION

The Bicron tech-50™ is a portable survey meter which uses 2 internally mounted GM tubes for the detection and measurement of ionizing radiation.

The instrument features a recessed meter movement, single on-off range selector switch, dead time compensation, and response time optimized for each of five linear ranges.

1.1 SPECIFICATIONS

RADIATION DETECTED: Gamma and X-ray.

DETECTOR: 2 GM tubes, internal.

RANGE: Linear ranges of 0-5, 0-50, 0-500, 0-5000, 0-50,000 mR/h

ACCURACY: Within 15% of reading for ^{137}Cs between 20% and 100% of full scale on any range.

ENERGY RESPONSE: $\pm 20\%$ from 80keV to 1.2MeV

WARMUP TIME: None

SATURATION: Typically >1000 R/h on each range with exclusive anti-saturation circuit.

RESPONSE TIME: Optimized for each range. 0-90% of final reading as follows:

<u>RANGE</u>	<u>TIME</u>
5mR/h	8 sec.
50mR/h	4 sec.
500mR/h	1 sec.
5R/h	1 sec.
50R/h	< 1 sec.

TEMPERATURE: Operational from -20° to $+60^{\circ}\text{C}$.

HUMIDITY: $<5\%$ change in reading from 10-95% RH.

CONTROL: Eight-position rotary switch - off, bat., HV, X1000, X100, X10, X1, X0.1.

BATTERY COMPLEMENT: Single 9-volt (MN1604 or equal). The additional battery holder may be used as storage of spare or parallel-wired.

BATTERY LIFE: >100 hours or >200 hours with parallel option.

HV TEST: Exclusive self test to verify detector HV power supply.

DISPLAY: Ruggedized, recessed, high-torque 1 mA meter with 3.35 inch (8.5cm) scale marked 0-0 mR/h, 'Bat. ok', 'HV ok'. Meter protected by impact-resistant Lexar® polycarbonate window.

GEOTROPISM: Within $\pm 2\%$ of full scale.

SHOCK: 100g per lightweight machine of MIL-STD 202C, method 202B.

VIBRATION: 5g in each of three mutually orthogonal axes at one or more frequencies from 10-33Hz.

CONSTRUCTION: Splash-proof, shock proof, two-piece all-metal case. Scratch-resistant laminated control panel and Bicron Kleen-Krome® trim on case top, durable black polyurethane painted handle and case bottom.

SIZE: 4.25 X 8 X 6" including handle (10.8 X 20.4 X 15.2 cm).

WEIGHT: 2.2 pounds (1 kg).

2.0 BATTERY INSTALLATION

BATTERY TYPE: 9-volt Mallory MN1604 or equivalent.

PROCEDURE:

1. Turn instrument off.
 2. Open pull catches at ends of case and separate case bottom from top.
 3. Install battery in appropriate clip on bottom circuit board (clip for spare battery is so marked), observing proper polarity.
 4. Replace bottom, orienting rubber pad under battery; close catches.
- PARALLEL-WIRED OPTION: Instruments with this option have both battery clips wired into the circuit. Installing a second battery thus provides twice the operational hours of one battery. Only one battery is needed to power the instrument, however.

2.1 BATTERY TEST *****SAFETY PRACTICE*****

Turn control switch to the "bat." position; a meter reading within the "bat. OK" range should be observed.

This test allows monitoring of the condition of the battery.

2.2 HIGH VOLTAGE TEST *****SAFETY PRACTICE*****

Turn control switch to the "HV" position; a meter reading within the "HV OK" range should be observed.

This test allows monitoring of the high voltage to the detector.

2.3 RADIATION MEASUREMENTS

1. To make a radiation measurement, turn the selector switch to one of the five linear ranges (X0.1, X1, X10, X100 or X1000).
2. Position the instrument so that the radiation is incident on the front of the case.
3. Multiply meter scale reading X selector position to obtain reading in mR/h.

*****CAUTION*****

An external source of ionizing radiation of the type the instrument was designed to measure must be used to determine proper operation of this instrument.

3.0 CIRCUIT DESCRIPTION

The electronic circuitry is contained on three interconnected printed circuit boards.

Modern solid-state integrated circuitry is used throughout. The major components are:

1. High-voltage power supply. A feedback-regulated, electronically stabilized supply for the GM tube potential. Additional circuitry provides HV readout on the meter scale.
2. Count-rate meter. A linear charge pump ratemeter converts the GM tube pulses to an exposure rate reading on the calibrated meter scale. The circuitry includes a unique dead-time compensation technique to provide nearly linear response over the full range, an anti-saturation circuit which forces the meter beyond full scale in high radiation fields, automatic time constant selection, and temperature compensation.

3.1 GM TUBES

1. The tech-50 utilizes 2 energy compensated GM tubes to cover its measurement range. The larger of the 2 is activated when the selector switch is in the X0.1, X1 or X10 position; the smaller when in the X100 or X1000 position.
2. A GM tube consists of a thin cylindrical shell which is the cathode, a fine wire anode suspended along the longitudinal axis of the shell, and an inert gas into which a small amount of a halogen gas is inserted to act as a quenching agent.

A potential of approximately 600 volts is maintained between the two electrodes with the anode always positive. This voltage is slightly less than that required to produce a discharge in the gas. When a nuclear particle or ray of sufficient energy enters the GM tube, it ionizes a molecule of the inert gas. Because of the high voltage maintained between the electrodes, the positive ions are attracted to the cathode and the electrons are attracted to the anode. In their movement toward the electrodes, these charged particles trigger the ionization of additional gas molecules, resulting in an avalanche of ions flowing between the electrodes. The gas discharge thus created is similar to the glow of a neon lamp. The tube conducts as long as the gas is in the ionized state.

The small amount of halogen gas in the gas mixture quenches the flow of ions, suppressing further electron avalanches until another nuclear particle or ray enters the tube. This flowing and quenching results in a rapid pulse or surge of current in the external circuit. The number of pulses per minute is approximately proportional to the radiation exposure rate. The meter, suitably connected to the tube, indicates the exposure rate on a calibrated scale.

4.0 CALIBRATION

The instrument is factory calibrated with ^{137}Cs gamma rays. Recalibration is required (a) after servicing, (b) if a GM tube is replaced, and (c) at regular intervals specified by the appropriate regulatory agencies.

The instrument is placed in a known radiation field with the incident radiation perpendicular to the front of the case. The GM tubes are mounted internally near the front of the case, as indicated by the alignment markings on the case bottom.

Individual calibration controls are provided for each range. They are used to adjust the meter reading to correspond to the known exposure rate. The locations of these controls are shown on a label in the case bottom.

Note:

Do not disturb the settings of any controls except those marked X0.1, X1, X10, X100 and X1000.

Calibration procedures should follow those specified by the appropriate regulatory agencies.

A detailed calibration procedure is part of the Q.C. Acceptance Procedure found elsewhere in this manual.

BICRON QC ACCEPTANCE PROCEDURE NUMBER 1017932

MODEL: tech-50TM

1. Perform visual inspection of finished product.
2. Remove the battery (both batteries if parallel-wired), and connect a 9.30V \pm .05V power source across the main battery terminals on the battery board. Perform the following calibrations:
 - a) Turn the control switch to "off". Mechanically zero the meter via the rear zero adjustment screw on the meter barrel.
 - b) Turn the control switch to "X1000". Check the +5V supply at pin 1 of U6 (ICL 7663). The reading should be 5VDC \pm 10%.
 - c) Leave the control switch set at "X1000" and connect a voltmeter between pins 1 (ground) and 15 of the 24 pin connector. Adjust R36 (50 Kohm zero pot) until the voltmeter reads 1 mVDC \pm 4/-1.
 - d) Turn the control switch to "X10" and connect a high voltage measuring device with an impedance \geq 1000 megohms across the larger of the 2 internal GM tubes (has a tin shield with small window). Adjust the high voltage supply to +600VDC \pm 3% via R52 (50 Kohm pot).
 - e) Rotate the control switch through all eight positions. High voltage should be detected only when the switch is in the X10, X1 or X0.1 position.
 - f) Connect the high voltage measuring device across the smaller GM tube and rotate the control switch through all eight positions. High voltage should be detected in the bat., HV, X1000 and X100 positions only. Remove the HV measuring device.
 - g) Turn the control switch to "HV" and adjust R34 (500 ohm span pot) until the meter reads in the center of the "HV ok" checkband.
 - h) Calibrate the instrument isotopically as follows:
 - 1) Position the unit so that the 2 GM tubes are in the proper fixed geometry within a known ^{137}Cs radiation field.
 - 2) Turn the control switch to "X1000" and expose the unit to the field intensity needed for calibration at 80% of full scale (see Table T-1). Adjust R30 (5 Kohm X1000 calibration pot) until the meter reads 80% of full scale.
 - 3) Test linearity by exposing the unit to the field intensity needed to make the unit read 20% of full scale (see Table T-1).
 - 4) Note the meter readings obtained in steps 2) and 3) on a Certification of Calibration.
 - 5) Repeat steps 2), 3) and 4) for the X100 range (using R28, the 50 Kohm X100 calibration pot), the X10 range (using R26, the 50 Kohm X10 calibration pot), the X1 range (using R24, the 500 Kohm calibration pot) and the X0.1 range (using R22, the 5 megohm calibration pot).

TABLE T-1

<u>Range</u>	<u>Field Strength mR/h</u>	<u>Acceptable Meter Reading mR/h</u>
X1000 (80%)	40,000	34,000 - 46,000
X1000 (20%)	10,000	8,500 - 11,500
X100 (80%)	4,000	3,400 - 4,600
X100 (20%)	1,000	850 - 1,150
X10 (80%)	400	340 - 460
X10 (20%)	100	85 - 115
X1 (80%)	40	34 - 46
X1 (20%)	10	8.5 - 11.5
X0.1 (80%)	4	3.4 - 4.6
X0.1 (20%)	1	.85 - 1.15

3. Test anti-saturation circuit operation as follows:
 - a) Turn the control switch to "X10" and connect a 100 megohm resistor across the larger GM tube. The meter should peg beyond full scale momentarily.
 - b) Replace the 100 megohm resistor with a 200 megohm resistor. The meter should remain near zero (meter fluctuations are due to GM tube activity).
4. Remove all test equipment from the unit. Turn the control switch to off and install a new + 9V alkaline battery (MN-1604 or equivalent) in the appropriate battery clip (either clip if the unit has the parallel-wired battery option).
5. Complete, date and sign a Certificate of Calibration.

SPARE PARTS LIST
BICRON Tech-50

SCHEMATIC SYMBOL	DESCRIPTION	PART NO
Main PC Board Assembly		
		1017012
C1,C10,C26	Capacitor, 0.1 uF, Film	9211041
C2,C22,C23	Capacitor, .001 uF, 1 kV cer.	9201021
C3	Capacitor, .001 uF, Film	9211021
C4,C24	Capacitor, 33 uF, 10 V tan.	9233361
C8	Capacitor, 200 pF, N750 cer.	9202011
C9,C21	Capacitor, .22 uF, Film	9212241
C11	Capacitor, .47 uF, Film	9214741
C12,C13,C18	Capacitor, 1.0 uF, 10 V tan.	9231051
C14	Capacitor, 2.2 uF, 10 V tan.	9232251
C17,C25,C28	Capacitor, .047 uF, Film	9214731
C19,C20	Capacitor, .01 uF, 1 kV cer.	9201031
C27	Capacitor, .01 uF, Film	9211031
D1,D2,D4-D6,D9-D19	Diode, 1N4148	9600002
D7,D8	Rectifier, 2 kV PIV	9600001
Q1	Transistor, 2N4126	9610002
Q4	Transistor, 2N4124	9610001
R1,R3,R6	Resistor, 10k, 1/4w, 5%	8510024
R2,R49	Resistor, 390 ohm, 1/4w, 5%	8539004
R4	Resistor, 1k, 1/4w, 5%	8110014
R5,R7,R9	Resistor, 4.7k, 1/4w, 5%	8147014
R8,R19,R37,R42,R43, R44,R45,R54,R58, R59	Resistor, 1 meg, 1/4w, 5%	8110044
R10,R48	Resistor, 49.9k, 1/4w, 1%	8549924
R11,R56	Resistor, 23.7k, 1/4w, 1%	8523724
R12,R13,R20	Resistor, 100k, 1/4w, 5%	8110034
R14,R57	Resistor, 274k, 1/4w, 1%	8527434
R18,R40,R41,R51	Resistor, 470k, 1/4w, 5%	8147034
R21,R38	Resistor, 1 meg, 1/4w, 1%	8510044
R22	Trimpot, 5 meg	9395051
R23,R55	Resistor, 100k, 1/4w, 1%	8510034
R24	Trimpot, 500k	9395041
R25	Resistor, 10k, 1/4w, 1%	8510024
R26,R28,R36,R52	Trimpot, 50k	9395031
R27	Resistor, 20k, 1/4w, 1%	8520024
R29	Resistor, 2k, 1/4w, 1%	8520014
R30	Trimpot, 5k	9395021
R32	Resistor, 4.99k, 1/4w, 1%	8549914
R33	Resistor, 82.5k, 1/4w, 1%	8582524
R34	Trimpot, 500 ohm	9395011
R35	Resistor, 249 ohm, 1/4w, 1%	8524904
R39	Resistor, 11k, 1/4w, 1%	8511024
R46	Resistor, 1000 meg, 1%	8810071

R47	Resistor,	499k,	1/4w, 1%	8549934
R50	Resistor,	2.7k,	1/4w, 5%	8127014
R53, R60	Resistor,	200k,	1/4w, 1%	8520034

RN1	Res. Network, 7 x 220k		8822031
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U1	Int. Ckt.,	MC3302PDS	9640002
U2	Int. Ckt.,	MC1453BBCPDS	9650004
U3	Int. Ckt.,	MC14093BCPDS	9650001
U4, U5	Int. Ckt.,	CA3160BEX	9640001
U6	Int. Ckt.,	ICL7663CPA	9640003
U7, U8	Int. Ckt.,	CD4016BEX	9650002

XFMR	Transformer,	M8149	9500001
	Connector,	24-pin	9780001

Switch PC Board Assembly 1017022

C29	Capacitor,	.001 uF, Film	9211022
R31	Resistor,	681 ohm, 1/4w, 1%	8568104
SW1	Switch,	Rotary, 8 pos.	9560005
	Header,	24-pin	9780002

Detector PC Board Assembly 1017030

R63, R64	Resistor,	3.3 meg, 1/4w, 5%	8133041
V1	GM Tube Ass'y, Energy-compensated		9730011
V2	GM Tube Ass'y, Energy-compensated		9730003

Battery PC Board Assembly 9420001

Case Top Assembly 1017142

Handle		9710001
Meter		9400014
Meter Window		9400011
Meter Support Bracket		9850002

Case Bottom Assembly 1017050

Miscellaneous

BT1

Battery, 9V alkaline, MN1604	9750001
Carrying Strap (option)	9973006
Knob, Function	9770003
Manual, Operator's	1017902
Spare Parts List	1017912
Schematic Circuit Diagram	1017922

Part No. 1017912

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Model: TECH-50 Portable Survey Meter



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Features

- GAMMA AND X-RAY DETECTION
- UP TO 50 R/h
- FAST, ACCURATE RESPONSE
- EXCLUSIVE HV CHECK
- ANTI-SATURATION CIRCUIT
- DEAD TIME COMPENSATION
- LIGHTED METER OPTION

U.S. Patent #4,617,680

GENERAL: The TECH-50 model is a portable GM survey meter designed for gamma/x-ray exposure rate measurements over a wide range of radiation levels. The two internal GM detectors used are energy compensated (see energy response curve).

Rugged construction and quality components make it durable, and the instrument is easy to service. Internal components are laid out on modular circuit boards. Span, HV and calibration pots (one for each range) are clearly marked.

The exclusive HV check assures that the detectors are operating at their

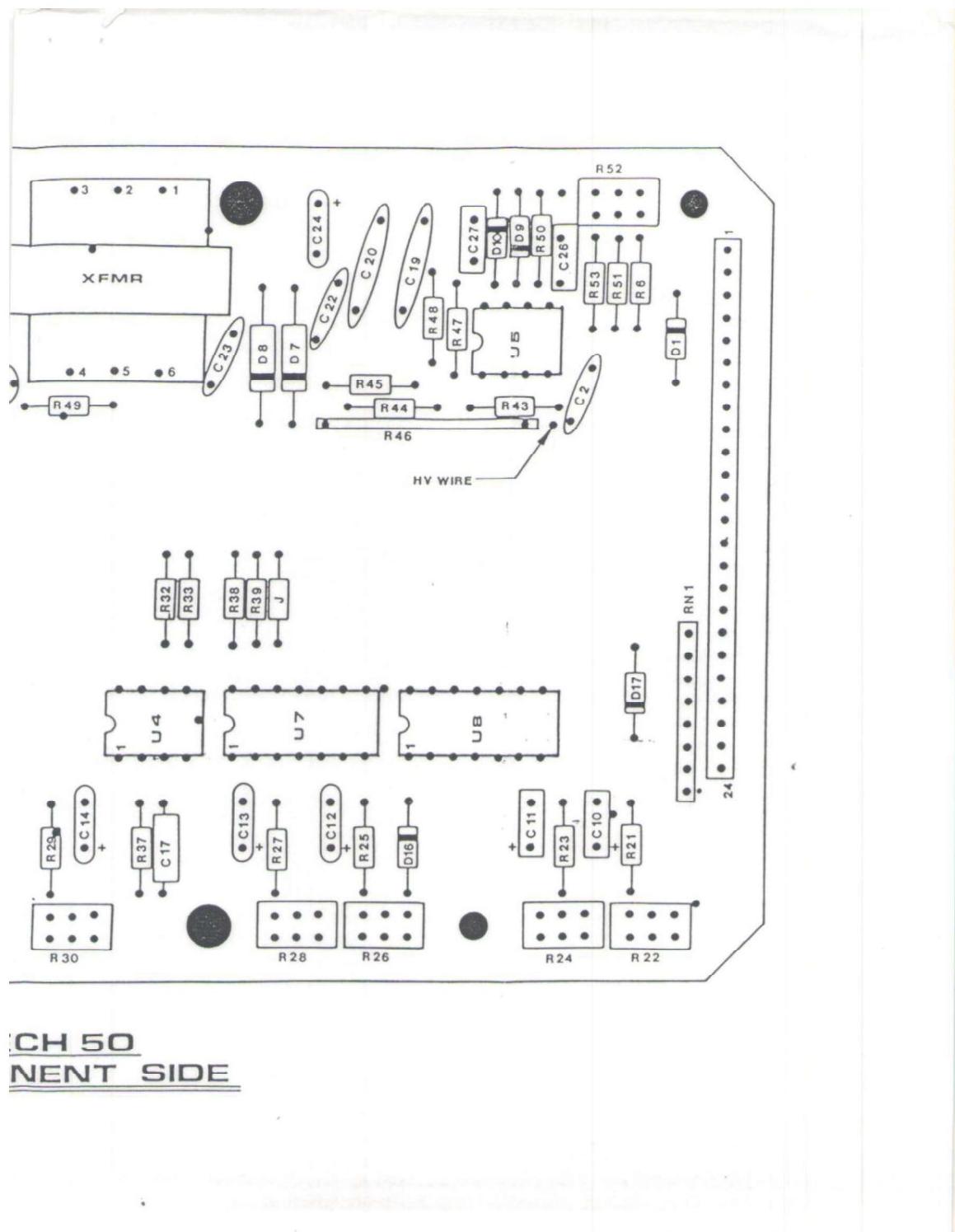
proper high voltage (critical for operation near the "edge" of a GM detector plateau).

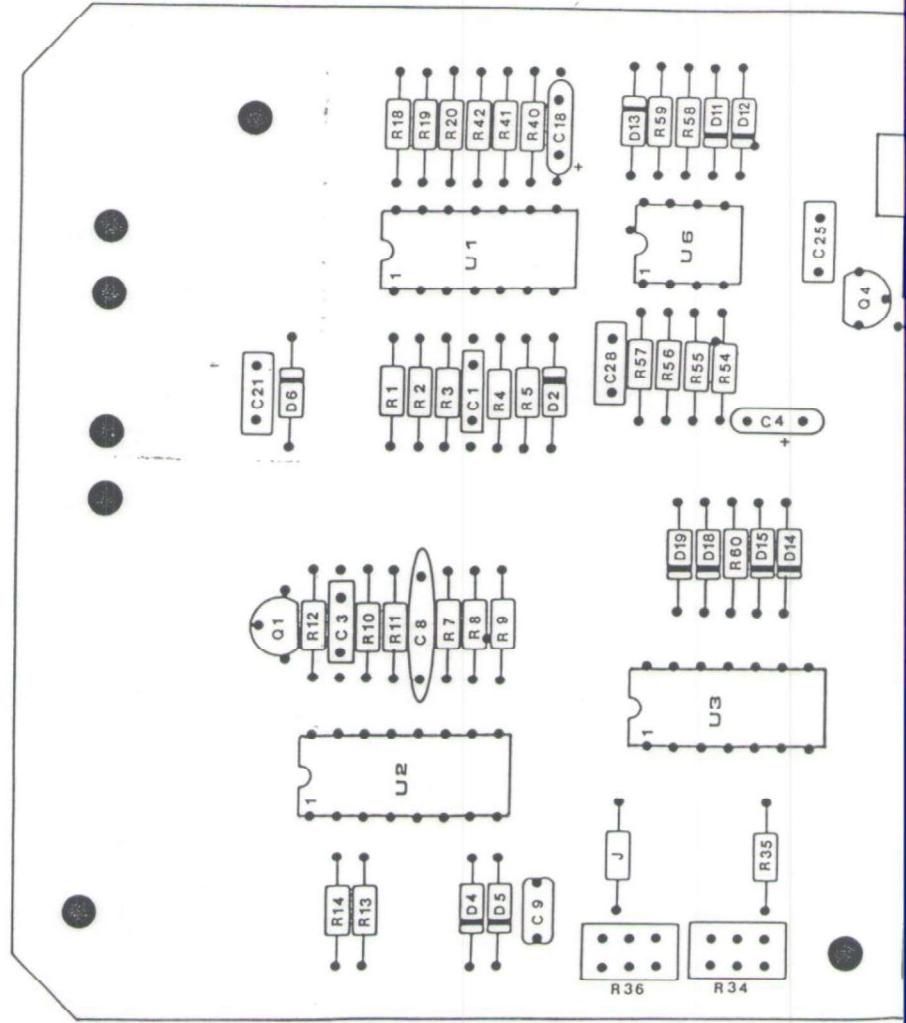
The anti-saturation circuit keeps the meter reading off scale when the detector saturates in a high radiation field, providing an added safety margin.

Automatic dead time compensation assures the accuracy of higher exposure rate readings for linear response on all ranges.

A single 9-volt battery powers the instrument.

A lighted meter option is available for the TECH-50. Built-in lights illuminate the meter face when a pushbutton switch in the handle is pressed.





TEC
COMPON

